

Running head: Developing an intervention to reduce respiratory infection transmission

**Development of an intervention to reduce transmission of respiratory infections and pandemic flu: measuring and predicting hand-washing intentions.**

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**Abstract**

This was an exploratory pilot study forming part of a programme of work to develop and trial an effective web-based intervention to reduce the risk of transmission of respiratory infections by promoting hand-washing and other preventive behaviours in pandemic and non-pandemic contexts. The main purpose of this study was to confirm that the behavioural determinants we had identified from theory were related as predicted to intentions, and to establish the validity of our measures of behavioural intentions.

Participants (N = 84) completed a self-report web-delivered questionnaire measuring intentions to engage in hand-washing and the hypothesised behavioural determinants of intentions, based on the Theory of Planned Behaviour and Protection Motivation Theory. In a factorial 2X2 design half the participants were first randomised to receive messages about potential negative consequences of pandemic flu (the 'high threat' condition) and half were assigned to receive 'coping' messages describing the rationale and effectiveness of hand-washing for reducing the risk of

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infection. A substantial proportion of variance in intentions was explained by measures of attitudes (instrumental and affective), social norms (descriptive and injunctive), perceived behavioural control (especially access to hand-gel), and perceived risk (in particular, the likelihood of catching pandemic flu). Our measures of intentions were sensitive to between group differences, and although our design did not permit causal inference (particularly in view of selective dropout among those required to read most web-pages) the pattern of differences was in the expected direction, i.e. hand-washing intentions tended to be stronger in those receiving the high threat message and coping messages.

This study provided encouraging confirmation that our intervention development was proceeding correctly. Measures of intentions proved sensitive to group differences, and the behavioural determinants included in the study explained a substantial proportion of the variance in intentions. The study also provided useful indications that our high threat message might increase hand-washing intentions, that providing hand-gel might be beneficial, and that it would be necessary to actively manage the risk of selective dropout in the intervention group.

Keywords: health promotion; internet; human influenza; hand-washing

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## **Background**

Acute respiratory infections are still one of the commonest reasons for sickness certification, representing a significant burden to the individuals concerned and to society (Leaker, 2008). Influenza and other respiratory viruses result in overstretched primary care services, as 20-30% of the population consult primary care for these symptoms at least once each year (HMSO, 1994), and the cardiovascular and respiratory complications from these viruses result in hospital bed shortages (Meier, Jick, Derby, Vasilakis & Jick, 1998; Woodhead, Macfarlane, Mccracken, Rose, & Finch, 1987; Madjid, Naghavi, Litovsky, & Casscells, 2003). Minimising the spread of respiratory infections could therefore have considerable benefit for both patients and the health service. This may be particularly important when an influenza pandemic occurs, since interventions to minimise spread of influenza could potentially reduce the peak incidence of infection, thus helping maintain the viability of health and other public services and allowing the development of vaccine protection (Bell, Nicoll, Fukuda, Horby, Monto, Hayden et al., 2006).

Systematic reviews suggest that frequent hand-washing may be an effective means of reducing transmission, although the evidence is not yet definitive and problems with adherence to recommendations are common (Bell et al., 2006; Jefferson, Foxlee, Del Mar, Dooley, Ferroni, Hewak et al., 2008; Rabie & Curtis, 2006; Sandora, Taveras, Shih, Resnick, Lee, Ross-Degnan et al., 2005). Interventions to promote hand-washing are likely to have relatively small effect sizes and will only be cost-effective if they can be delivered at low cost to a large population. The internet would appear to be a potentially valuable medium for delivering such an intervention, as it can be accessed conveniently at any time in the home by the majority of the population and can be personally tailored to individual circumstances and beliefs. Web-based interventions can be made widely available at minimal cost and can be rolled out very rapidly compared with most other modes of

delivery (for example, in the event of a pandemic). We are aware of only one previous intervention that has attempted to reduce transmission of influenza using a web-based intervention (Bourgeois, Simons, Olson, Brownstein, & Mandl, 2008). Tailored messages were sent to participants throughout the winter, and positive trends in behaviour were observed during this period, although no significant effect on hand hygiene was found in this small study.

Our aim was to develop an effective web-based intervention to reduce the risk of transmission of respiratory infections between household members. The MRC guidance for developing complex interventions recommends that the first phase should consist of ‘theoretical modelling’, i.e. using theory and empirical evidence to identify the relevant factors influencing behaviour and corresponding mechanisms of action for intervention components (Craig, Dieppe, Macintyre, Michie, Nazareth, & Petticrew, 2008). The approach we used for this phase was the PRECEDE-PROCEED model (Green & Kreuter, 1999). This model proposes that intervention developers should first consider which behaviours are clinically useful and then confirm which of these are most feasible and acceptable to the target population. Having identified hand-washing, cough and sneeze etiquette, mask wearing and social distancing as potentially clinically useful behaviours (with the strongest existing evidence for hand-washing), we carried out a focus group study that suggested that members of the community felt that hand-washing was the most feasible and acceptable preventive behaviour (Morrison & Yardley, 2009). The next steps are to identify the psychological and environmental ‘behavioural determinants’ influencing performance of the target behaviour, develop intervention components that will influence these behavioural determinants, and pilot the intervention components and outcomes measures (Craig et al., 2008; Green & Kreuter, 1999). The purpose of the study presented here was therefore to confirm that the behavioural determinants we had identified were

indeed related to hand-washing intentions, and to pilot some key outcome measures and intervention components.

We selected the Theory of Planned Behaviour (Ajzen, 1991) as the main framework for identifying, addressing and measuring the behavioural determinants. This model is flexible enough to be applied in a wide variety of contexts, it can be combined with other models and predictors, and there is evidence that components of the model that are amenable to change by intervention are key predictors of health-related behaviour (Godin & Kok, 1996; Sutton, 2002; Webb & Sheeran, in press). We applied the model to developing the ‘coping’ web-pages used in this study by constructing messages that would lead participants to perceive hand-washing as necessary, effective, socially desirable and easy to do.

A key question that we hoped the present study could help to answer was whether we also needed to address the perceived threat posed by pandemic flu. Empirical evidence from studies of anticipated responses to flu and actual responses to the SARS epidemic suggests that perceived threat (including both anxiety about flu, perceived susceptibility to infection and perceived severity of consequences) may be an important predictor of adoption of preventive measures such as hand-washing (Lau, Yang, Tsui, & Kim, 2003; Lau, Kim, Tsui, & Griffiths, 2007; Leung, Ho, Chan, Ho, Bacon-Shone, Choy et al., 2005; Leppin & Aro, 2009; Rubin, Amlot, Page & Wessely, 2009). Conversely, there is also evidence that interventions that increase perceived threat in order to promote healthy behaviour can be ineffective or even counter-productive (Albaraccin, Gillette, Moon-Ho, Earl, Glasman, & Durantini, 2005; Witte, 1998). Protection Motivation Theory (Rippletoe & Rogers, 2006) predicts that ‘fear appeals’ are less likely to be effective if they generate so much anxiety that maladaptive responses are triggered, such as denial and avoidance. However, both theory and research indicate that messages that increase perceived risk

without causing significant anxiety may promote adaptive coping, especially if combined with coping messages (Witte & Allen, 2000).

In this study, we examined the effects on intended hand-washing of both threat and coping messages. We expected that hand-washing intentions would be greatest in those receiving messages intended to increase perceived risk of pandemic flu (without provoking excessive anxiety) and those receiving messages promoting positive coping behaviour, and predicted that the combination of both messages would result in the most positive intentions. However, this exploratory pilot study was not designed as (or powered for) a definitive test of these predictions. Specific objectives of this study were:

a) to confirm that the behavioural determinants we had identified were related to intentions;

b) to establish the validity of our measures of behavioural intentions and behavioural determinants in terms of their sensitivity to the effects of our threat and coping messages.

## **Method**

### ***Design and procedure***

Half the participants were randomly assigned to the low threat condition, in which they were presented with a short factual definition of pandemic, or the high threat condition, in which they were presented with messages that spelled out some of the potential negative consequences of the pandemic. In a factorial 2X2 design, half the participants were also randomly assigned either to receive no coping messages, or to read several web-pages describing the rationale and effectiveness of hand-washing for reducing the risk of catching and passing on flu. All participants then completed a self-report web-delivered questionnaire measuring intentions to engage in hand-washing and the hypothesised behavioural determinants of intentions. The web-delivered intervention and

questionnaires were created and data collected using the LifeGuide software for developing and evaluating internet interventions (Yardley, Osmond, Hare, Wills, Weal, de Roure et al., 2009). The full text of the messages and the questionnaire is given in Additional file 1.

Participants were recruited by advertisements placed around the university campus, by email messages sent to various departments across fifteen UK Universities. The study took place between mid-May and mid-July 2009, at a time when a pandemic had recently been declared by the WHO; by the end of the study period the number of estimated new cases identified in the UK was several thousand a week and rising rapidly. The UK government had therefore initiated a campaign to promote hand hygiene (among other measures), including a booklet delivered to every household during May and an advertisement campaign. As incentives to participate, participants were informed that taking part in the study would offer an opportunity to learn about pandemic flu and how to reduce the risk of catching it, and they would be entered into a prize draw for £150. Participants logged onto the website via a url provided in the advertisements and completed an informed consent sheet; they were then randomised automatically to one of the four factorial conditions.

### ***Theory-based messages***

As described in the introduction, the Theory of Planned Behaviour (Ajzen, 1991) provided the overall framework for the content of the coping web-pages providing advice on hand-washing for reducing the risk of catching and passing on flu. We also drew on self-determination theory (Deci & Ryan, 1998), which suggests that to maximise effectiveness advice should not be presented as an exhortation to perform prescribed behaviours. Instead, recipients should be provided with a meaningful rationale (to enhance their sense of competence) and support to select and achieve personal goals (Chatzisarantis & Hagger, 2007). The specific beliefs to be addressed were identified from our focus

group study of attitudes to hand-washing (Morrison & Yardley, 2009) and from a meta-analysis of anthropological studies of hand-washing (Curtis, Danquah & Aunger, 2009). While Protection Motivation Theory (Rippletoe & Rogers, 2006) was the basis for the content of the web-pages describing the threat posed by pandemic flu, to ensure that our web-pages covered all the salient aspects of people's models of illness and infection we referred to Leventhal's 'common-sense model' of health and illness (Leventhal, Brissette & Leventhal, 2003). Following the emphasis in the PRECEDE-PROCEED model on environmental as well as intra-individual factors influencing behaviour (Green & Kreuter, 1999), proposed behavioural determinants included household context (including the attitudes and behaviour of other household members) and access to soap and water or handgel. To inform the presentation of our messages we followed best practice in the use of textual and graphical format, use of illustrations etc. (Whittingham, Ruiter, Castermans, Huiberts & Kok, 2007).

The low threat webpage presented a brief description of pandemic flu as a new flu virus that spreads widely because there is no immunity in the population. The high threat webpage emphasised the high personal risk of catching flu and passing it to family members, explained that healthy adults had died from pandemic flu in the past, and suggested that in a severe pandemic access to medical care might be available only to the worst cases. The coping web-pages used in this study were a small sub-set of those prepared for the main trial, comprising the key pages intended to initially motivate hand-washing. The web-pages selected for this study: provided a rationale for how transmission of viruses by hand contact could be reduced by hand-washing, and scientific evidence of the efficacy of hand-washing to reduce infection rates; made suggestions for how frequent hand-washing could be easily incorporated into daily routines; addressed common concerns

that frequent hand-washing would result in dry hands; and evoked disgust responses to having dirty hands.

### ***Measures***

Where more than one item was combined to form a scale, the summed score was divided by the number of items in the scale to permit comparative interpretation of means across scales with different numbers of items.

#### *Measures of hand-washing intentions*

Three Theory of Planned Behaviour items scored from 1 (agree strongly) to 7 (disagree strongly) were used to assess intentions to carry out hand-washing ‘at least 10 times a day’ (the recommended behaviour), ‘more often’ and ‘as often as possible’ (these items were used to assess intended improvement to less than 10 times a day, or in those already hand-washing 10 times a day). We also measured intended frequency of hand-washing in the future and current frequency on a scale from 1 (0-2 times a day) to 5 (10 times or more a day), with a mid-point of 5-6 times a day. To prevent infection transmission, hand-washing should be undertaken after touching any potentially contaminated surface, and before touching food or the face; hand-washing 10 times a day was selected as consistent with optimal expert recommendations (Jefferson et al., 2008) and representing a challenging but realistic target based on our qualitative piloting (Yardley, Miller, Teasdale & Little, 2010). By subtracting current from intended frequency we created a measure of intended increase in frequency of hand-washing; since this had a highly skewed non-normal distribution the variable was dichotomised into no intended increase vs. some intended increase.

#### *Measures of Theory of Planned Behaviour behavioural determinants*

All Theory of Planned Behaviour items were scored from 1 to 7 and were phrased in terms of views of hand-washing 10 times a day. Three semantic differential items

formed a direct measure of instrumental attitude to hand-washing (useless/useful, necessary/unnecessary, bad/good), and three items measured affective attitude, in terms of how hand-washing would make the respondent feel (worried/confident, proud/embarrassed, sensible/foolish). Two items (referring to ‘people whose opinions I value’ and ‘people who are important to me’) were used to assess injunctive norms (‘they think I should wash my hands’) and descriptive norms (‘they wash their hands’). The direct measure of perceived behavioural control originally comprised two items, measuring the self-efficacy (‘I am confident that I could wash’) and perceived control (‘it is up to me whether or not I wash’) dimensions, preceded by ‘If I wanted to’ to hold motivation constant (Ajzen, 2002; Rhodes, Blanchard & Matheson, 2006). However, since these items only correlated .27 in this study they could not be used as a unitary scale, and so the self-efficacy item was retained, as it was more highly correlated with intention (.20 vs .10).

Salient behavioural and control beliefs were derived from our qualitative studies, described above. The scale of control beliefs had poor reliability ( $\alpha = .44$ ) due to inconsistent responding to reverse scored items, and so only individual positively scored control beliefs were included in the analyses below. Subjective norms were assessed with reference to the opinions of ‘people living with you’, ‘most people’ and ‘health experts’.

#### *Other measures*

Risk was assessed by two items assessing perceived likelihood of catching pandemic flu if no preventative action was taken, plus an item assessing perceived severity of the consequences of flu for health and an item assessing anxiety about catching flu (to capture the emotional dimension of perceived threat) (Lepin & Aro, 2009; Brewer & Chapman, 2007). Finally, we assessed age, gender, and whether respondents were living with someone aged less than 16.

#### *Data analysis*

Since the aim of this study was to establish likely effect sizes for the main trial, and the study was not powered to test hypotheses, effect sizes rather than statistical significance are reported throughout. These are based on bivariate and partial correlations for analysis of relationships to intentions, and partial eta squared values derived from MANOVAs for the analyses of sensitivity of measures to between group differences. Partial eta squared can over-estimate effect sizes when a large number of factors are analysed and interactions are large, but the discrepancy between eta squared and partial eta squared is minimal in 2 way designs with small interaction effects, as in our study (Levine & Hullett, 2002). Multiple hierarchical regression was used to determine the proportion of the variance explained by perceived risk and each of the constructs in the theory of planned behaviour, entering all these variables in a single step. Logistic regression was used for the analyses of the effect of group membership on intended increase in hand-washing, as this was a dichotomous variable. There were only a few isolated missing data values, which were not replaced since it was not important to use the complete sample in all analyses in this pilot study.

## **Results**

### ***Participant characteristics***

A total of 102 people logged onto the website; 34 were randomised to low threat/no coping messages, 24 to low threat/coping messages, 23 to high threat/no coping messages, and 21 to high threat/coping messages. Of these, 84 people (82.4%) completed the measures of intention, comprising 32 (94.1%) in the low threat/no coping messages group, 21 (87.5%) in the low threat/coping messages group, 19 (82.6%) in the high threat/no coping messages group, and only 12 (57.1%) in the high threat/coping messages group. This indicates a trend towards selective dropout among those required to read more web-pages, which proved significant on chi-square testing ( $\chi^2 = 12.83$ , 3df,  $p = .005$ ).

Among the 84 people who completed the outcome measures, 64 (76.2%) were women, 16 (19%) were men and 4 did not give their gender. The mean age was 32.7 (s.d. 11.82), and 48 (57.1%) reported living in a household with children under the age of 16.

### ***Relationship of behavioural determinants to intention***

Relationships of the behavioural determinants to intention are shown in Table 1. As expected, most of the theory of planned behaviour constructs had a medium to strong relationship to intention. Perceived risk of catching flu also had a medium strength relationship with intention, while perceived behavioural control, anxiety about flu and perceived severity of consequences of flu had only weak relationships with intention. Multiple regression (Table 2) confirmed that perceived risk and each of the constructs in the theory of planned behaviour all made a small independent contribution to explaining variance in intention, after controlling for the effect of the other constructs in the equation; . In combination, these variables explained 58.8% of the variance in intentions; the theory of planned behaviour constructs explained 57.2% of the variance on the first step of the regression, and perceived risk explained a further 1.6% on the second step.

Multiplying the risk of catching flu by perceived severity of consequences only marginally increased the correlation with intention (from .40 to .41), so these variables were examined independently in subsequent analyses. Similarly, multiplying behavioural, normative and control beliefs by the value attached to these beliefs consistently resulted in slightly lower correlations with intention compared with un-weighted beliefs, and so only un-weighted behavioural and control beliefs and subjective norms are reported here.

### ***Sensitivity of measures to group differences***

Observed differences in hand-washing intentions between groups were very consistent (see Table 3); those in the high threat condition and those receiving coping messages had stronger intentions to increase hand-washing, and those in the high

threat/coping messages group had the strongest intentions. Effect sizes of between group differences in intentions are shown in Table 4. Note that although the conventional terminology of ‘effects’ of group membership is used for convenience below, causation cannot be inferred from this cross-sectional study, particularly in view of the selective dropout which co-varied with group membership.

There was a medium effect size of threat condition on the Theory of Planned Behaviour measures of intention (combined), and a small effect of coping messages, with no interaction. Examination of the individual intention items revealed that the less precise measures (intending to wash hands more often or as often as possible) were most influenced by the high threat message, whereas the most precise measure of the target behaviour (intending to wash hands at least 10 times a day) was most influenced by the coping messages. Indeed, there was a medium to large effect of coping messages on intended hand-washing frequency. However, those receiving coping messages also tended to report a slightly higher frequency of current hand-washing. Logistic regression was therefore carried out to determine whether intended hand-washing frequency was greater than current hand-washing frequency among those receiving coping messages. Those receiving coping messages had a likelihood 2.44 times greater (95% C.I. 0.96 to 6.18) of intending to increase their frequency of hand-washing. In contrast, threat condition had very little effect on intended increases in hand-washing frequency (odds ratio = 0.93, 95% C.I. 0.36 to 2.38).

Effect sizes from analyses of the combined behavioural determinants of intention (see Table 4) show a large effect of coping messages on attitudes, with only a small effect of threat level. There were medium size effects of both threat level and coping on the combined measures of social norms, perceived behavioural control and perceived threat. In general, only small interactions between threat level and coping messages were observed.

The pattern of findings for the individual measures of attitudes, social norms, perceived behavioural control and perceived threat are shown in Tables 5 and 6 (see Table 1 for corresponding effect sizes). Attitudes (instrumental and affective) and behavioural beliefs showed a similar pattern as intentions, with generally more positive attitudes to hand-washing in the high threat condition and among those that received coping messages. There was a particularly strong effect of coping messages on instrumental attitudes, with a medium size effect on behavioural beliefs. Coping messages had a medium size effect on normative beliefs, but as would be expected there was very little effect of group on descriptive norms. Group effects on individual measures of perceived behavioural control and perceived threat were mainly small, but there was a medium size effect of coping messages on the belief that it would be easy to find time for hand-washing, and a medium size effect of threat level on perceived risk of catching flu.

## **Discussion**

This study confirmed that most of the behavioural determinants we had identified had at least medium strength associations with hand-washing intentions, and in combination explained a substantial proportion of the variance in intentions. We also established that our measures of intentions were sensitive to between group differences, and the pattern of differences was in the expected direction, i.e. hand-washing intentions tended to be stronger in those receiving the high threat message and coping messages. While intentions were therefore strongest in those receiving both threat and coping messages the effects appeared to be mainly additive, and the interaction between threat and coping messages was typically weak, which is consistent with findings from most previous studies of the effects of threat and coping messages (Witte & Allen, 2000).

Because of selective dropout in the group required to read both threat and coping web-pages, we cannot confidently attribute group differences to the effects of reading our

web-pages. Those who were willing to read both the threat and coping messages may have been motivated by pre-existing higher levels of concern about flu and/or positive attitudes to preventive behaviours, which were then reflected in the group differences we observed. However, there are some indications that group differences may not have been entirely due to pre-existing attitudes. There was a substantial increase in intentions to increase the frequency of hand-washing after controlling for reported current hand-washing levels. Moreover, the specific pattern of group differences is consistent with our specific messages. For example, the effects of the coping messages appeared to be strongest for the attitudes and intentions most strongly promoted by our coping pages (i.e. the attitude that hand-washing is useful and the intention to carry out hand-washing at least 10 times a day) rather than simply reflecting a tendency towards generally more fearful, socially desirable or positive responses.

Perceived risk of catching pandemic flu was independently related to hand-washing intentions and reading the high threat message was associated with more positive attitudes and intentions and greater perceived risk. Anxiety about catching flu and perceived severity of the health consequences of flu had weaker associations with intentions and were less influenced by reading the high threat message. This suggests that the level of threat we described in our high threat message may prove sufficient to motivate adaptive responses such as hand-washing rather than maladaptive responses such as denial (Witte & Allen, 2000).

It is encouraging that our messages appeared to have effects on perceived risk and hand-washing intentions despite this survey being carried out in the context of intensive media coverage and government advice regarding the risk of flu and necessity for hand hygiene. It is possible that this reflects the value of 'priming' or reinforcing these attitudes and intentions (which are unlikely to be strongly held), even when there is a high level of

general awareness of the desirability of hygienic behaviour (Bargh & Chartrand, 1999; Conner & Sparks, 2002; Sheeran, 2002). Another possibility is that our detailed, theory-based messages were more effective than those encountered in the media and government advice, which tended to consist of brief endorsement of hand hygiene with no explanation of exactly why hand-washing might help or how it should be implemented.

While this study generated positive findings regarding the relevance of the behavioural determinants we had identified, the sensitivity and validity of our measures of intentions and the appropriateness of our messages, it also highlighted important methodological issues requiring further attention. Our measures of perceived behavioural control and control beliefs proved inadequate, due to inconsistent responding to different dimensions of perceived control and to reverse-scored items. Further work is needed in order to develop reliable measures of this construct, which is typically one of the most important predictors of intentions and behaviour.

More importantly, the selective dropout observed in this survey draws attention to the risks associated with the design we employed here and propose to employ for the main trial, in which measures of intended behaviour and related constructs will be completed by all participants only after the web-delivered intervention. The rationale for this design was that administering questionnaires asking people to reflect on their behaviour and the reasons for it may itself act as an intervention, resulting in an unintended change in the attitudes and behaviour of the control group. However, our findings have highlighted the danger that less motivated participants in the trial may be more likely to drop out before follow-up than control participants because of the considerable additional effort required to participate, resulting in a similar confounding of pre-existing motivation, adherence and outcomes. It will therefore be imperative to implement a range of procedures to minimise loss to follow-up, such as: clearly differentiating between emails requesting completion of

important outcome measures and reminders to use the website if they wish to; encouraging participants to complete outcome measures even if they have chosen not to engage with the intervention; using telephone follow-up to obtain brief outcome measures from non-respondents. We will also require participants randomised to the intervention arm to complete baseline measures, which will allow us to model the extent to which outcomes may be influenced by pre-existing characteristics of those who drop-out.

It should be noted that this survey focused principally on the rational motivations for intended rather than actual behaviour – whereas the main trial of the intervention will evaluate the health outcomes of actual behaviour, i.e. the incidence and transmission of respiratory infection. It is well known that intentions are valuable but far from perfect predictors of behaviour (Webb & Sheeran, in press). Hand-washing is likely to be strongly influenced by non-rational factors such as habit, cultural norms and practical issues such as access and forgetting (Curtis et al., 2009). For this reason, our planned intervention will incorporate strategies to help people plan for and overcome these barriers, for example by placing reminders around the home, providing hand-gel, and involving other family members in the change process. It should also be noted that this developmental study was carried out in a convenience university sample, and so it will be vital for future research to examine its effectiveness in a more representative community sample.

## **Conclusions**

The purpose of this study was to provide an evidence-base for the development of an intervention to promote increased hand-washing by confirming that the behavioural determinants we had selected were associated with hand-washing intentions, and by piloting our outcome measures and some of the proposed intervention components. The findings provide early indications that the intervention development is proceeding correctly to date. Our measures of intentions proved sensitive to group differences, and the

behavioural determinants we included in the study explained a substantial proportion of the variance in intentions.

This study also provided an opportunity to explore specific aspects of the intervention design that we were undecided or concerned about. As highlighted in the introduction, we were aware that threat messages could be ineffective or even counter-productive, and so it was encouraging that both our threat and our coping messages appeared to be associated with more positive intentions, even though the design of this study did not permit a test of whether this was a causal effect. We had been considering supplying hand-gel to participants in the interventions to reduce barriers to hand-washing, and so it was interesting to observe that the perceived benefits of access to hand-gel emerged as a dimension of perceived control that was particularly closely related to intentions, suggesting that supplying hand-gel may indeed be valuable. The selective dropout among those required to read most web-pages in this study also served as an important reminder to us of the need to manage the risk of selective dropout in the intervention group in the main trial of the intervention.

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## Tables

Table 1: Reliability (Cronbach's alpha) of measures of behavioural determinants of intention, their correlation with intention (Pearson's coefficient) and effect sizes (partial eta squared) from multivariate analyses (MANOVA) of the effects of threat level and coping messages

Behavioural determinant	Cronbach's alpha	Correlation with intention	Threat effect	Coping effect	Threat*coping effect
Instrumental attitude	.87	.70	.03	.13	.02
Affective attitude	.86	.65	.02	.01	.01
Behavioural beliefs	.84	.64	.01	.05	.02
Descriptive norms	.96	.53	.00	.01	.01
Injunctive norms	.71	.65	.02	.03	.03
Normative beliefs	.75	.52	.01	.07	.00
Perceived behavioural control	-	.20	.00	.01	.01
Control belief: access to soap and water	-	-.11	.02	.00	.00
Control belief: finding time	-	.19	.02	.06	.00
Control belief: hand gel availability	-	.50	.01	.02	.01
Perceived risk of catching pandemic flu	.90	.41	.05	.00	.00
Anxiety about catching pandemic flu	-	.31	.00	.01	.00
Perceived severity of consequences	-	.32	.03	.03	.01

Table 2: Multiple regression of prediction of intention from behavioural determinants

Behavioural determinant	Partial Correlation	Beta
Instrumental attitude	.39	.40
Injunctive norm	.27	.25
Control belief: hand gel availability	.22	.17
Perceived risk of infection	.19	.14

Table 3: Means and standard deviations for scores on measures of hand-washing intentions and frequency as a function of threat level and coping messages

Measure and threat level	No coping messages	Coping messages
Intention scale (combined measure)		
Low threat	4.02 (1.88)	3.78 (2.05)
High threat	3.33 (1.68)	2.61 (1.48)
Intend to wash hands at least 10 times a day		
Low threat	4.50 (2.14)	3.86 (2.13)
High threat	3.05 (1.84)	2.33 (1.92)
Intend to wash hands more often		
Low threat	3.47 (2.13)	3.76 (2.23)
High threat	3.05 (1.84)	2.33 (1.92)
Intend to wash hands as much as possible		
Low threat	4.09 (2.23)	3.71 (2.72)
High threat	2.95 (1.78)	2.50 (1.57)
Intended frequency of hand-washing		
Low threat	3.47 (1.05)	4.19 (0.98)
High threat	3.32 (1.38)	4.17 (0.94)
Current frequency of hand-washing		
Low threat	3.09 (1.09)	3.62 (1.12)
High threat	3.16 (1.34)	3.58 (1.17)

Note: Scores could range from 1 (strongly agree) to 7 (strongly disagree) for Theory of Planned Behaviour intention measures, and from 1 (0-2 times a day) to 5 (10 or more times a day) for hand-washing frequency items.

Table 4: Effect sizes (partial eta squared) from multivariate analyses (MANOVA) of the effect of threat level and coping messages on intended hand-washing behaviour and behavioural determinants

Measure of intended hand-washing behaviour	Threat effect	Coping effect	Threat* coping effect
Intention measures (combined)	.06	.02	.00
Intend to wash hands at least 10 times a day	.02	.03	.00
Intend to wash hands more often	.04	.00	.01
Intend to wash hands as often as possible	.06	.01	.00
Intended frequency of hand-washing	.00	.11	.00
Current frequency of hand-washing	.00	.04	.00
Attitudinal measures (combined)	.03	.15	.03
Normative measures (combined)	.04	.07	.05
Perceived behavioural control measures (combined)	.08	.08	.02
Perceived threat measures (combined)	.07	.05	.02

Note: Conventionally, for partial eta squared an effect size of 0.01 is regarded as small, 0.06 as medium, and 0.14 as large (Cohen, 1988).

Table 5: Means and standard deviations for scores on measures of attitude and social norms as a function of threat level and coping messages

Measure and threat level	No coping messages	Coping messages
Instrumental attitude		
Low threat	3.28 (1.52)	2.59 (1.55)
High threat	3.22 (1.43)	1.61 (0.98)
Affective attitude		
Low threat	3.51 (1.42)	3.46 (1.29)
High threat	3.37 (1.33)	2.85 (1.31)
Behavioural beliefs		
Low threat	2.77 (1.08)	2.51 (1.28)
High threat	2.85 (1.13)	1.98 (1.35)
Descriptive norm		
Low threat	4.41 (1.60)	4.50 (1.40)
High threat	4.72 (1.24)	4.18 (1.27)
Injunctive norm		
Low threat	3.67 (1.21)	3.65 (1.53)
High threat	3.75 (1.17)	2.82 (1.42)
Normative beliefs		
Low threat	3.02 (1.11)	2.31 (1.02)
High threat	2.65 (1.18)	2.15 (0.95)

Note: Scores could range from 1 (strongly agree) to 7 (strongly disagree).

Table 6: Means and standard deviations for scores on measures of perceived behavioural control and perceived risk as a function of threat level and coping messages

Measure and threat level	No coping messages	Coping messages
Perceived behavioural control		
Low threat	2.03 (1.30)	1.53 (1.17)
High threat	1.67 (0.97)	1.73 (1.85)
Control belief: access to soap and water		
Low threat	1.97 (1.30)	1.84 (1.02)
High threat	2.28 (1.36)	2.36 (1.75)
Control belief: finding time		
Low threat	3.16 (1.72)	2.26 (1.59)
High threat	2.61 (2.06)	1.73 (0.91)
Control belief: hand gel availability		
Low threat	2.29 (1.51)	3.05 (2.25)
High threat	2.11 (1.28)	2.36 (2.06)
Perceived risk of catching pandemic flu		
Low threat	4.68 (1.48)	4.66 (1.54)
High threat	3.81 (1.85)	4.04 (1.18)
Anxiety about catching pandemic flu		
Low threat	4.77 (1.69)	5.21 (1.78)
High threat	4.72 (1.60)	4.83 (1.40)
Perceived severity of consequences		
Low threat	3.87 (1.36)	3.53 (1.90)
High threat	3.61 (1.82)	2.67 (1.72)

Note: Scores could range from 1 (strongly agree) to 7 (strongly disagree)

## **Additional material**

Additional File 1 -

**File name:** survey 1 materials.doc

**File format:** Microsoft Word document

**Title of data:** Messages and questionnaire

**Description of data:** Threat and coping messages, and questionnaire provided to study participants